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PROJECTING HOUSEHOLD DYNAMICS
A Scenario-Based Microsimulation Approach

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Abstract

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Two methods are brought together to estimate and analyse future household structure. Application of a *scenario method* results in the construction of differing context scenarios. These context scenarios function as alternative societal environments of the future household system. Given these context scenarios and, tentatively derived, general hypotheses relating relevant elements of the context scenarios and household processes, future input parameters of the household model are postulated. Subsequently, *microsimulation* is used to calculate the future household structure. Emphasis in the article is on methodology, rather than on substantive issues which have a mainly illustrative function.

Résumé

Nelissen, J.H.M. et A.P. Vossen, 1989, Une méthode de projection des ménages: Approche en microsimulation basée sur des scenarios (en anglais), European Journal of Population/Revue Européenne de Démographie 5, 253–279.

Deux méthodes sont réunies en vue d'estimer et d'analyser la structure à venir des ménages. L'application de *scénarios* conduit à élaborer différents contextes qui vont alors servir de milieux sociaux alternatifs pour les mariages à venir. Sur la base des scénarios, élaborés à titre d'essai, et des hypothèses générales portant sur les éléments pertinents de ces contextes et de ces processus, on pose alors les paramètres qui joueront un rôle dans le modèle de projection. A la suite de cela, on utilise une approche en *microsimulation* pour évaluer la structure des ménages à venir. L'accent est mis ici sur la méthodologie, plutôt que sur des résultats pratiques, qui ont essentiellement un rôle d'illustration.

1. Introduction

One of the most prominent characteristics of 20th century society is the longstanding and continuous trend towards individualism, reflected in, among other things, the way people live together and form and dissolve household units. One outcome is that it is now far more difficult to make accurate forecasts of future household composition.

In traditional models, household composition is determined by extrapolating various series of headship-rates. In times of major societal changes the extrapolation of time series can, however, lead to deterministic and conservative pictures of the future. A scenario approach offers the opportunity of unfolding more creative and goal-oriented views. The headship-rate method cannot guarantee consistency with the assumed underlying trends (e.g. of fertility and family formation processes), but the microsimulation approach has solved the kind of consistency problems involved.

In this article a household projection system is designed, and its central methodological features, namely a scenario approach and the application of microsimulation, are further elaborated. In the following, we will refer to family households only. Since the usefulness of the system designed can best be judged by its application, we have applied it to the situation in the Netherlands. The application is for illustrative reasons only, and, in consequence, the system is no more than tentatively implemented. This applies especially to the actual construction of the context scenarios, the formulation of key hypotheses derived from household theory and the assumptions about future values of the projection model's parameters. It goes without saying that, in view of these restrictions, the simulation results are not intented for planning and policy purposes.

In section 2, the main principles of microsimulation are explained for those who are less familiar with the subject. Thereafter – in section 3 – the scenario construction is described and general hypotheses are formulated, relating the main elements of the context scenarios to processes of household formation and dissolution. In the same section, the conceptualization of the household system is dealt with, and this is followed by an overview of the assumptions made about the future state of the key parameters of the household model, as deduced from the combination of the context scenarios and household 'theory'. Section 4 comprises a summary and brief commentary on the simulation results. In the final section, the analyses are evaluated and some discussion points are raised.

2. Microsimulation

Traditional demographic forecasts are limited to the events of birth, death and migration. Marriage and divorce are included in a number of very special cases only (the Netherlands, Great Britain and Norway). This results in a restricted disaggregation of the population by age, sex and (sometimes) marital status. The individual's position in the household and those of his or her relatives are subsequently 'externally' determined by static methods such as the headship-rate method. In making a forecast, however, this method is inappropriate. Its shortcomings are partially done away with by macrosimulation. Macrosimulation breaks the population down by relevant categories and the resulting groups of individuals may experience transitions from one category to another during a certain period of time (Keilman and Keyfitz, 1988, p. 267). However, the main disadvantage of macrosimulation is its restricted capacity of disaggregation owing to the limited number of states or categories that can be brought into analysis (see e.g. Keilman, 1988).

This restriction ceases to exist when microsimulation is used. Microsimulation operates at the micro level, and as a consequence it produces very detailed information, such as distributions, life histories and data for subpopulations. The method was proposed some decades ago by Orcutt (1957). Developments in computer hardware, especially in speed and disk capacity, have reduced computer costs substantially, increasingly favouring the application of microsimulation (see e.g. Hellwig, 1988). Household projections can now be executed in a consistent and more flexible manner. This is all the more important now that a growing interest in housing forecasts, is found beyond their traditional sphere of planning for housing. In this respect, we can mention the relevance of household composition for the female labour supply, for determining the level of social security benefits and payments, for the discussion on reforms of the social security system and the tax system, and so on (see Clarke, 1986).

2.1. Main principles of microsimulation

Microsimulation can be described as an analysis of the behaviour of the system under investigation (in our case a population), using characteristics (such as sex, marital status, age, etc.) of the micro-units (individuals and households) distinguished with the aid of a model that describes the functioning of the system. In this way we can determine the manner in which the situation of each of the micro-units changes as a consequence of internal and external factors influencing the system. When applying microsimulation, the population is represented by individual microdata. Individuals are the point of departure. During the simulation process, the individuals are grouped to obtain families and households. All processes are simulated by means of Monte Carlo simulation techniques. Each individual is exposed to risk k (for example out-migration) under probability $p(k,\dots)$ and the population structure results from each individual history. In this example, a computer routine gives a random number and compares it with the probability $p(k,\dots)$ that event k will occur to our individual X during a given period of time. If the number drawn is smaller than or equal to the probability $p(k,\dots)$, the event k will occur and in this example individual X will emigrate. The simulated population can be considered to be the realization of a stochastic process, a random sample of the real population. The simulated and observed population will differ randomly for two major sources of variability, which are a consequence of the method used. The first source is the variance related to the specification of the initial sample population. The second (Monte Carlo variability) is the variance associated with the sampling approach used to select the particular members of the model population whose characteristics change during each year of the simulation (see Orcutt et al., 1976, ch. 11).

Although microsimulation has been applied to a number of demographic tasks (see Giesbrecht and Field, 1969; Bongaarts, 1983; Howell and Lehotay, 1978; Heer and Smith, 1968; and Hammel et al., 1976), its use has actually been rather limited. The main reason for this has been the limitations of computer capacity. Because microsimulation results are subject to sampling errors and Monte Carlo variability, the number of family histories that have to be simulated is comparatively very large. Nowadays, this no longer creates insurmountable problems, and simulation results have become very reliable (see for example Steger, 1980). In the aforementioned studies, however, the problem of computer capacity was very clear: only some one hundred family histories could be simulated, which meant that relatively rare events or family characteristics were not represented.

The most important advantages of microsimulation are:
- there is no need to transpose behavioural relations from the micro level to the macro level. This is especially important in the case of applications in the social sciences, because aggregation of theories to the macro level has often not been realized, except where very restrictive assumptions were made (see Kirnan, 1989);
- the available information becomes highly differentiated;
- the most complicated and interdependent relationships can be described, even simultaneously;
- it is relatively easy to maintain consistency, which is a general methodological problem in modelling household and family dynamics (see e.g. Galler, 1988);
- assumptions and hypotheses with respect to micro-units can be introduced or changed at any time;
- the method is intuitively appealing because it uses existing units (e.g. persons). Disaggregated relationships are normally simpler and clearer than aggregated relationships.

However, we also have to mention some disadvantages of microsimulation:
- the behavioural hypotheses are often founded on insufficient theoretical knowledge;
- large data bases are needed, or also have to be simulated.
- the construction and maintenance of microsimulation models require large investments;
- the need for computer capacity and time is very large;
- the forecasting value of microsimulation models has not yet been sufficiently evaluated at present.

These drawbacks are partly a consequence of practical problems, which can be solved, and are partly connected with the fact that the method used is more elaborate than currently used methods. In our view, the disadvantages do not outweigh the advantages.

2.2. The microsimulation model NEDYMAS

Our model NEDYMAS (The NEtherlands DYnamic Micro-Analytic Simulation model) can be described as a dynamic cross-section simulation model: every year, the characteristics of all micro-units are adjusted or simulated (household position, age, marital status, number of children and so on), and data from preceding years can also be used. In this way a hypotetical sample of the (future) population is created from year to year. Interaction between the micro-units is possible at any moment in this context.

The complete model consists of three modules: a demographic module, a labour market and income module, and a social security module. Within these modules a number of submodules can be distinguished. At this moment, the following submodules are in operation:

- *within the demographic module*:
  Immigration, emigration, mortality, fertility, (re-) marriage and cohabitation, divorce and separation, splitting-off of children;
- *within the social security module*:
  old-age pensions, disability pensions, sickness benefits, family allowances, social welfare benefits, unemployment benefits, social security payments;
- *within the labour market and income formation module*:
  labour force participation, disability, unemployment, education, wage income and taxes.

Interaction exists within the modules themselves as well as between the submodules of the different (main) modules. The (sub)modules, in combination with the characteristics of the preceding period, determine the characteristics of the system in the current period, and so on. Additional input may also be needed. For example, the level of education of candidates for marriage influences the matching process. This means that the labour market module (of which education is a submodule) influences the demographic module. Age and marital status affect wage income, so the demographic module will influence the income formation module, and so on.

In this contribution we will use only the demographic module to demonstrate the power of the tool. The main reason for this is that behavioural relationships in the demographic module are not (yet) present.

The demographic module is an important element of the model. Apart from the fact that it produces essential input for the other, more central modules, it can – as a by-product – be used on its own to generate continuously the household structure of the population. In this article we will use the model to investigate some 'extreme' values of household structure for the Netherlands in 2010.

For the Netherlands and most other countries, the application of microsimulation is very interesting and useful, since, in the regular statistical system, information of this kind (flow data) is lacking. Statistics on household structure in the Netherlands are available only for years in which censuses were held (1947, 1960 and 1971). Since about 1980 a number of surveys (stock data) have provided information on household structure. Thus, hardly any information is available on the household history of individuals. Our model allows the generation of household structures at any given moment, and in order to do so it uses individual household histories. Because the model forms part of a complete socio-economic model, it is also possible to incorporate socio-economic variables affecting demographic processes in the future.

The organization of the microdata file is as follows. The microdata file contains a record for each individual. Apart from a range of household variables, the record contains personal characteristics, for example sex, marital status, number of children, position with respect to the reference person of the household, year of marriage, year of immigration, level of education, and so on. Persons living in a stable union, whether married or not, are allocated an indicator for their partner. The parents of each person, if alive, are also given an indicator.

Each year the simulation process starts with the *ageing* of the population. Thereafter the number of *new immigrants* is determined. New immigrants lead to an increase in the number of personal records. In the next step, every individual is subjected to the following processes. First, *emigration* and *re-migration* and *family reunion* of former immigrants take place. Next, *mortality* is simulated, after which it is determined whether the individual is a *marriage* candidate or a candidate for *cohabitation*. Then, divorce and separation or decohabitation are simulated, after which *matching of persons* takes place to complete the simulation of marriage and cohabitation. The last steps are the simulation of *fertility* and the *splitting-off of children*. The next year can then be simulated. A more detailed description of the demographic

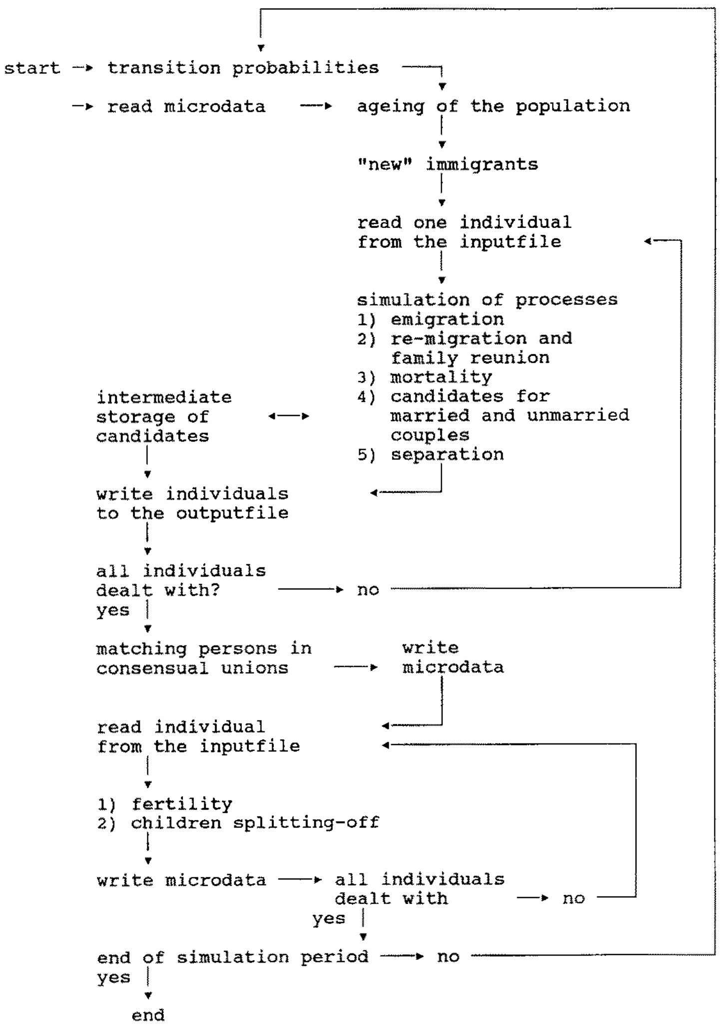

Fig. 1. The demographic simulation module.

Table 1
Review of the variables used in the demographic model.

Submodule	Variables
Immigration	Year of birth, age, marital status, year of previous emigration if applicable, probability of immigration without family, probability of return migration
Emigration	Analogous to immigration
Death	Year of birth, age, sex and marital status
Leaving parental home	Year of birth, age, sex, nuptiality rate, probability of cohabitation, participation in high education
Marriage	Year of birth, age, sex, marital status, age difference of partners, level of education of both partners
Cohabitation	Analogous to marriage (excluding marital status)
Divorce	Year of birth, age, sex, marital status, number of children, age difference of partners
Dehabitation	Analogous to marriage (excluding marital status)
Fertility	Year of birth, age, marital status, living together or not, number of live born children

module can be found in Nelissen (1989). An outline of the process is presented in fig. 1. The variables used in the demographic module are given in table 1 and an overview of the personal characteristics that are used is given in table 2.

In microsimulation models the problem of competing risks has usually been ignored. The problem has, however, been tackled in a very elegant way by Hellwig (1988) who introduced random sequences. In our model, the problem is solved by using occurrence-exposure rates instead of transition probabilities. The initial population, which amounted to 15000 in 1985, was derived from the 1947 Census and updated to 1985 using NEDYMAS (see Nelissen, 1989).

Table 2 gives an impression of the power of microsimulation and the large amount of differentiated simulation it provides. For example, we can generate the distribution of people by year of birth, year of death, year of leaving parental home, year of immigration, year of emigration, whether partner emigrated with or without reference person, number of siblings, sex, marital status, number of children, number of children with former partner, year or birth of children, year of cohabitation, year of marriage, level of education of the person in question and his or

Table 2
Personal characteristics and range used in the demographic model.

Variables	Range
Year of birth	1848, 1849,...,2009
Year of dying	1947, 1948,...,2009
Id. no. of individual	
Id. no. of mother	
Id. no. of father	
Id. no. of household	
Year of leaving parental home	Year of birth + 15, year of birth + 16, ...,year of birth + 35
Year of emigration	Year of birth, year of birth + 1,..., Year of dying
Year of immigration	Year of birth, year of birth + 1,..., year of dying
Partner emigrated	Yes, no
Number of siblings	0, 1,...,19
Marital status	Never married and not cohabiting, never married and cohabiting, married, divorced and not cohabiting, divorced and cohabiting, widowed and not cohabiting, widowed and cohabiting
Sex	Male, female
Number of children (n)	0, 1,...,20
Number of children allocated to partner when separated (p)	0, 1,...,20
Year of birth of children	Year of birth + 15, year of birth + 16,...,year of birth + 34 ($n \times$)
Id. no. of children ($n \times$)	
Id. no. of children allocated to partner ($p \times$)	
Year of cohabitation	Year of birth + 15, year of birth + 16,...,year of birth + 84
Year of marriage	Year of birth + 15, year of birth + 16,...,year of birth + 84
Level of education	Five types
Year of separation	Year of cohabitation (or marriage), year of cohabitation (or marriage) + 1,..., year of birth + 85
Id. no. of partner	
Year of widowhood	Year of marriage, year of marriage + 1,...,99

her partner, year of separation, year of widowhood, and all this simultaneously. If we wanted to generate the same information by macrosimulation we would need $152 \times 100 \times 21 \times 100 \times 100 \times 2 \times 20 \times 20 \times (35 \times 20) \times 70 \times 70 \times (5 \times 5) \times 85 \times 85 = 1.6 \times 10^{24}$ states, and consequently a matrix of 1.6×10^{24} by 1.6×10^{24}, which means 2.5×10^{48} cells! And in the case of macrosimulation, we do not know who is whose partner or child, whereas this kind of information is also available from microsimulation. When using a database of 15 000 persons, we need only about 25 megabytes to store these persons, the computer programme and the data.

3. Household scenarios for the year 2010

We now proceed with a presentation of steps which have to be undertaken in order to produce household scenarios. A scenario can be described as a sequence of images of a system's future, based on creative speculation. The scenario approach applied in this paper is in fact a simplified version of a more sophisticated elaboration that has recently been proposed by one of the authors of this article (Vossen, 1988). It differs from a mere 'time-series'-based projection approach in two respects.

First of all, it interpolates rather than extrapolates – which means in the first instance that an outline of a future demographic system is designed for a fixed date (here, the year 2010), which is afterwards (by interpolation) connected with the current state of the demographic system. There are two reasons why we prefer an interpolating approach to an extrapolating approach: by interpolating, we can avoid the impact of too strong a 'mental involvement' with present and past; and by interpolating we do not depend that firmly on the availability of past time series of sufficient length, the latter being scarce in the case of household statistics in the Netherlands.

The second way in which the proposed scenario approach differs from the time-series-based projection approach is that demographic processes are explicity – by means of a theoretical frame of reference, or a useful substitute – embedded in their social environment. The future state of this social environment is systematically worked out in context scenarios. Contrary to trend extrapolation, scenario writing offers the perspective of a more coherent and consistent outlook on possible or desirable futures, thus making it more useful for planning and policy purposes.

For the household projection system, whose principal starting points have now been briefly clarified, the following steps must be taken successively:

- designing the future environment of the (Dutch) household system by constructing alternative *context scenarios*;
- formulating – be it only for this specific occasion, very rudimentary and at a high level of aggregation – hypotheses (functioning as a theoretical frame of reference) relating the main elements of the context scenarios to processes of household formation and dissolution (our *household 'theory'*);
- elaborating the conceptualization of the *household model*;
- formulating *assumptions* regarding the future key variables of the household system;
- running the computer programme, and subsequently, *presenting and commenting on the results.*

In the following subsections each step will be explained. We stress once again that emphasis will be placed on methodological issues.

3.1. Designing context scenarios

Three context scenarios will be outlined. One of them originates in the medium variant of a recent set of demographic trend projections, carried out by the Netherlands Central Bureau of Statistics and based on a conventional cohort component model (NCBS, 1987). To its output we will add – in agreement with the underlying key assumptions – the missing household dimension. Besides this 'official' scenario, based on recent trends, we will outline two scenarios of a future which substantially deviates in its structural nature from today's society. We thus strive to create more or less extreme border lines, but imaginable around the trends that are pictured in the first scenario, which, from now on, will be labelled the TREND scenario.

First of all we will deal with the construction of the border line scenarios which will be developed in two stages. We start from the postulate that demographic processes resulting in the formation and dissolution of households are not self-contained, but are influenced by an underlying social context. This postulate forces us to proceed at two levels. First, we have to construct context scenarios. At the second level these scenarios have to be translated into demographic household processes.

Let us now outline the frame of reference underlying the context scenarios. As stated above, this article focuses on methodological rather than on substantive issues. For this reason we only summarize the outcome of the more detailed and more thoroughly documented analysis presented in Vossen (1988).

The social context can be hypothetically decomposed into several demographically relevant dimensions. As such, we make a distinction between a society's *cultural system* (in particular its norms and values emerging in attitudes and aspirations towards household and family behaviour), and the prevailing *opportunity structure* (to be understood in its broadest sense, and thus containing all factors which either enable or obstruct the realization of demographic aspirations).

We distinguish as the leading subdimensions within the cultural system the trends towards secularism and individualism and those towards materialism. Economic growth and technological progress are considered to be the most significant subdimensions of the opportunity structure. Variables representing these subdimensions will be simply dichotomized. In order to maximize the discrepancy between the scenarios we assume that the three subdimensions of the cultural system are positively correlated. The same applies to the subdimensions of the opportunity structure. This leads to the assumption that increasing secularism goes hand in hand with increasing individualism as well as with increasing materialism and consumerism. As far as opportunity is concerned, we assume that economic growth and technological progress are developing in the same direction.

By crossing the key dimensions 'cultural system' and 'opportunity structure', and keeping in mind the differentiation we made, we obtain the following simplified classification of possible context scenarios (see fig. 2).

Fig. 2 shows that three cells are in fact filled, which means that three context scenarios will be used as the social environment for the household situation in the Netherlands in the year 2010; the selection criterion is their underlying discriminatory power. We will give only a concise characterization of the three distinct scenarios.

The label of the EGO-MAT scenario (upper cell left) contains elements of both the concepts 'EGO-oriented' and 'MATerialized; the latter refers to a consumerist attitude (the aspiration level), as well as a flourishing economic climate, favouring the realization of consumerist aspirations (the 'opportunity structure' level). EGO-MAT thus stands for a hedonistic and atomized, wealthy, high-tech, post-industrial society. The label of the SO-NOMAT scenario (lower cell right) stands

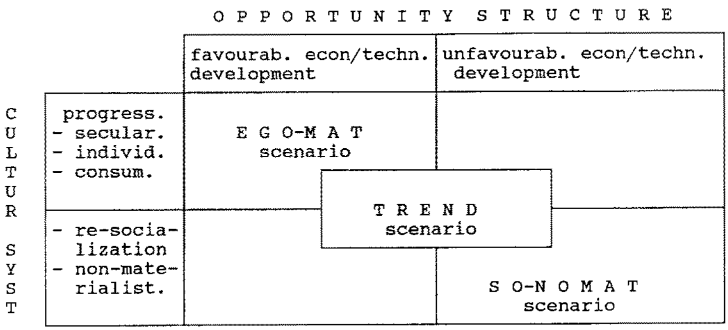

Fig. 2. Classification of context scenarios.

for 're-SOcialized' and NOn-MATerialistic' – the opposite of EGO-MAT – and can be briefly characterized as a post-materialist, molecularly structured, primary group-(re)oriented, post-industrial society. The epicentre of economic and political power is moved from the western-nordic hemisphere to the eastern-southern hemisphere, resulting in a stagnating economy and diminishing prosperity.

Finally the TREND scenario has – as indicated before – been thought of as the underlying social context emerging from a continuation of trends, in the absence of major ruptures in the prevailing cultural system as well as in the opportunity structure. Changes are gradual rather than structural. Although not explicity delineated in comparable concepts by its originators, this scenario can thus be tentatively situated around the 'crossroads' in the centre of the figure. The two empty cells – representing more or less intermediate scenarios – will not be elaborated.

3.2. Household theory

In our basic train of thought, the next step is to introduce household theory, as a 'trait d'union' between the highly aggregated context scenarios and the formulation of key assumptions regarding the future state of the household system. Household theory should – in a more or less compelling way – prescribe how social trends, the structuring of context scenarios, are translated into processes of household formation and dissolution.

Contemporary household theory is dominated by approaches based on a microeconomic frame of reference, which views household status as a composite good consisting of, among other things, privacy, companionship, and domestic service. Marriage, divorce, and home-leaving by young adults, as well as other household processes, are explained by the application of microeconomic models.

Burch and Matthews (1987) recently summarized the main findings of the major studies in this field into 9 hypotheses, relating changes in household composition to rising real income, availability of kin, changing preferences for privacy, role changes leading to household crowding, decline of household services, technology, recreation and companionship.

Since theory itself play only an illustrative role in this article, the basic relations between the main elements of the context scenario and household formation and dissolution, highly aggregated, will be postulated in two key assumptions derived from Burch and Matthew's hypotheses:

(a) tendencies towards secularism, individualism and materialism lead to a preference for privacy and independence and thus to a preference for smaller (but more homogeneously structured) households and separate living arrangements;
(b) favourable economic and technological conditions – manifested in high real income, high labour force participation rates (especially for women), a generous social security system as well as a well-equipped housing market – will enable individuals and couples to realize their household aspirations.

3.3. Conceptualization of the household system

As stated above, we now have to specify and translate the context scenarios into more differentiated demographic household processes. Which demographic determinants of family and household composition ought to be distinguished in this respect? Bongaarts (1983) lists the following variables: nuptiality, fertility, adoption, mortality, migration, divorce (together determining the composition of nuclear families) and headship prevalence, household formation, household transition and household dissolution (determining how nuclear families and remaining individuals combine to form households). In terms of the household phase cycle, these processes can be rearranged and classified as shown in fig. 3.

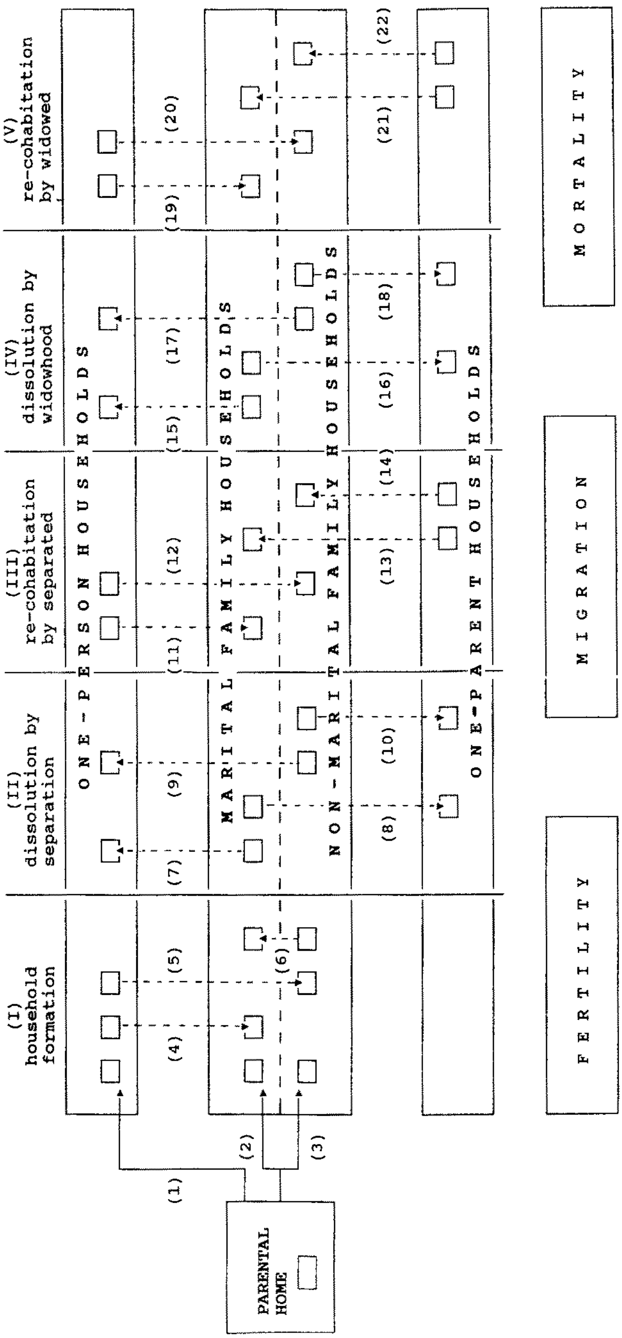

Fig. 3. Main streams of household formation and dissolution.

This diagram approximates – albeit at the conceptual level only – the operation of our microsimulation model NEDYMAS. Its special function here is to serve as a frame of reference to be used while stating assumptions about the future trends in household processes. As such, it should guarantee a certain degree of internal consistency within the system of assumptions.

Within a simply conceptualized life cycle, divided into 5 subsequent modules, 22 household formation and dissolution processes describe the transitions between 5 main household types, namely:

- parental homes,
- one-person households (including non-family households),
- marital family households (a family household headed by a married couple),
- non-marital family households (a family household headed by an unmarried couple),
- one-parent households.

In addition, the demographic key variables of fertility, mortality and migration are integrated and modelled to complete the household system. How do we proceed within the diagram? We should first determine a set of basic parameters of the composition of a population's household structure in the future – here, the year 2010.

Choosing a cross-sectional approach, we take 100 young female adults who leave their parental homes. They are divided along streams (1), (2) and (3) to their first destination in the household formation module (I): the formation of a one-person household (stream 1), a partnership in a marital family household (stream 2) or a partnership in a non-marital family household (stream 3). The corresponding numbers (out of 100) are placed in the small boxes within the diagram. Still within module I, transitions can take place from a one-person household into a partnership in a (non-)marital family household, by cohabitation (streams 4 and 5). Finally, a non-marital family household can – by marriage – be transferred to the category of marital family households (stream 6). Totalizing streams $(2)+(3)+(4)+(5)$, and dividing the sum by the aforementioned 100 female adults, given an expression for an overall 'pair formation risk' of the female population in the year 2010. In a longitudinal setting it indicates, in other words, the proportion of females ever involved in at least one pair-formation:

the complement is the proportion who permanently remain single. The term 'risk' is used as an expression of aggregated occurrence-exposure rate. The latter relates an observed number of demographic events to the population at risk – those who have undergone the logically preceding event.

Cohabiting women (either married or unmarried) are subsequently subjected to a fertility regime, which differentiates them according to their current status (married or unmarried), age and parity. At the same time, of course, they are subjected to mortality and migration risks.

In module II, dissolution by separation of marital as well as non-marital family households is schematically outlined. Separating childless couples are split up into two one-person households (stream 7 or 9), whereas separating couples with children are split up into (a) a one-person household (stream 7 or 9) and a one-parent household (stream 8 or 10), headed by a mother or a father, or (b) two one-parent households (stream 8 or 10). Totalizing streams (7) up to and including (10) and dividing the sum by the sum of streams (2) up to and including (5), as determined earlier, indicates an overall 'separation risk' of marital and non-marital family households. Marital and non-marital family households are submitted to different age-specific divorce or separation rates, taking into account the number of children present.

In module III re-cohabitation (non-first pair formation) by separated persons (either divorced or separated from a non-marital family household) is elaborated, and decomposed into streams (11) up to and including (14). The population at risk consists of streams (7) up to and including (10). Re-cohabitation rates are again differentiated according to age, status and parity.

In short, dissolution of marital as well as non-marital family households as a result of widowhood, as described in module IV – and determined as a function of male mortality – and subsequently, re-cohabitation by married or unmarried widows (module V) are modelled analogously to 'dissolution by separation' and 're-cohabitation of separated persons', as described above. For details see Nelissen (1989).

Generally speaking, it is advisable – for consistency's sake – to fill in the diagram from the top down: that is to say, to start by determining the diagram's marginals. What proportion will ever be engaged in pair formation? What proportion of family households will ever be dissolved by separation? How many couples will remain childless, how many will have 1, 2, 3 or more children? What will be the future life expectancy? And so on.

3.4. Household processes in the year 2010: Main assumptions

What has to be done next – before ultimately running the microsimulation model – is to formulate quantified assumptions about the parameters of the household formation and dissolution processes distinguished in the model, for the end of our projection period, the year 2010. Preferably, this step should be carried out by a Delphi-like procedure, in which a multi-disciplinary group of specialists is asked to fill in the diagram and discuss the different viewpoints. For this more illustrative application, the authors of this article filled in the diagram themselves. The resulting main parameters are presented in table 3.

All these quantified overall expressions of 'risk' are given an age specification by applying model schedules. For convenience's sake, the overall household risks are – in the operational phase – transposed into 'total rates' and supplied with timing parameters (mean age and variance). These transposed input parameters are presented in table A.1 of the appendix. The gamma function was used as the model schedule. For more details see Nelissen and Vossen (1989).

Table 3
Parameters household composition 2010.

	EGO-MAT	SO-NOMAT
	Overall occ./exp.rate	Overall occ./exp. rate
Pair formation	0.75	0.90
Separation	0.40	0.25
Recohabitation	0.25	0.40
Fertility (par. progr. rates)		
a(0)	0.60	0.90
a(1)	0.50	0.94
a(2)	0.33	0.65
a(3)	0.0	0.36
Life expectancy		
Males	76.0 yrs	81.0 yrs
Females	80.0 yrs	83.0 yrs
Migration		
Immigration	2 × level 1985	0.5 × level 1985
Emigration	Trend NCBS proj. '85	Trend NCBS proj. '85

4. Simulation results

In this section, the main simulation results are presented. Since emphasis was placed on methodology rather than on results, the latter will be displayed only roughly, in a number of graphs; a commentary on these will be given shortly. For more detailed figures we refer to Nelissen and Vossen (1988).

4.1. Population total and age structure

The population's age structure for the projection year 2010 (all three scenarios, as well as the situation in 1988) is shown in fig. 4. According to the TREND scenario, the population of the Netherlands will amount to 15.2 million, according to EGO-MAT 15.6 million, and according to SO-NOMAT 16.4 million. Differences may be attributed to the diverging assumptions, especially on fertility and migration. The larger population total in SO-NOMAT is the result of a large increase in the total fertility rate, whereas the relatively lower number in EGO-MAT is caused by relatively small birth cohorts, which were only partly offset by a growing net migration.

4.2. Marital status

As far as the partition of the population by marital status is concerned, the following remarks can be made. The percentage of

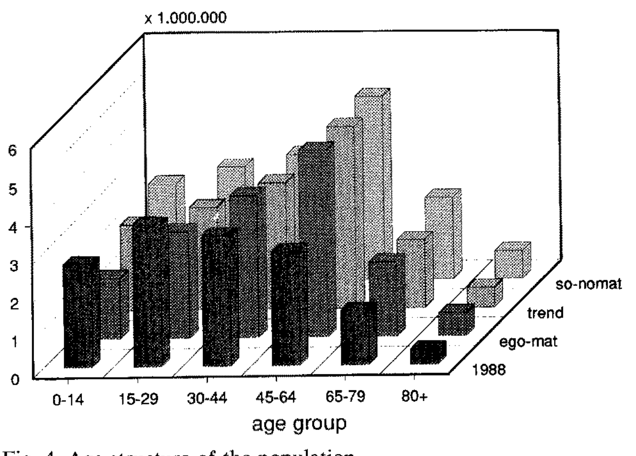

Fig. 4. Age structure of the population.

(married or not) cohabiting persons amounts to 52%, 55% and 67% for TREND, EGO-MAT and SO-NOMAT, respectively. There are substantial differences in the percentage of 'separated' persons, which reaches 9.4% for TREND, 7.4% for EGO-MAT and only 4.6% for SO-NOMAT. The relatively high percentage for TREND is due to the high divorce rate in the official 1985-forecast made by the Netherlands Central Bureau of Statistics. The percentages of 'widowed' people are not as widely divergent and are mainly determined by differing assumptions in the field of life expectancy and pair formation. To conclude the marital status overview, percentages 'never-married' reach values of 45, 51 and 47 for TREND, EGO-MAT and SO-NOMAT, respectively.

4.3. Number and size of households

The number of households amounts to 7.8 million in TREND, 8.2 million in EGO-MAT and 7.0 million in SO-NOMAT. In 1981, the number of households in the Netherlands was approximately 5.5 million. Note that 'multi-family households' as well as 'institutional households' are excluded. According to fig. 5, differences in average household size are considerable, varying from 1.90 (EGO-MAT) to 2.46 (SO-NOMAT). In EGO-MAT, 45% of all households are one-person households, as against 44% in TREND and only 19% in SO-NOMAT. The latter, however, has 15% more two-person households as compared with EGO-MAT, while the percentage of three-person households is

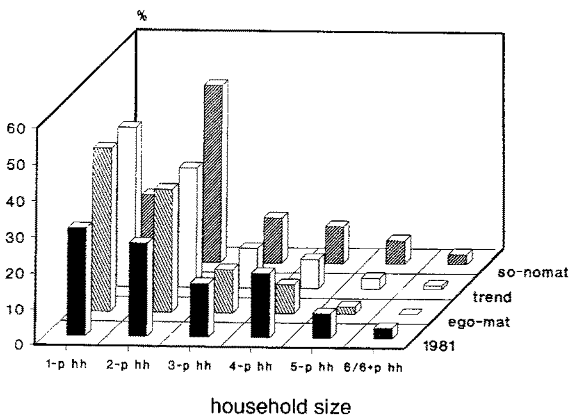

Fig. 5. Distribution of household by size.

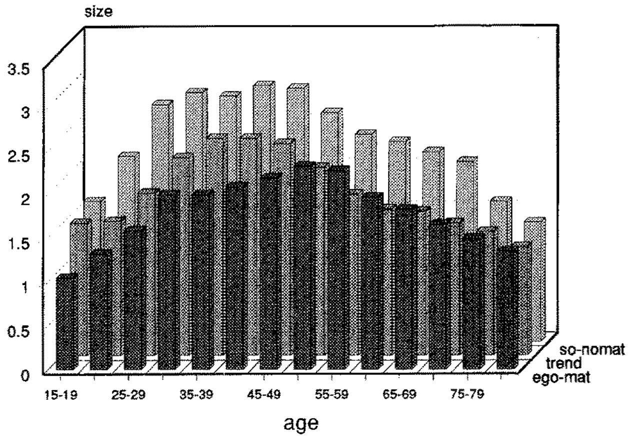

Fig. 6. Average household size by age of the reference person.

about the same in SO-NOMAT and EGO-MAT. Larger households (four and more persons) appear most frequently in SO-NOMAT.

The average household size by age of the reference person is shown in fig. 6. The differences between EGO-MAT and SO-NOMAT in this respect can be explained by two factors. For the younger age groups, differences are caused by a higher fertility level in SO-NOMAT, in combination with a lower age at first birth. For the older age groups, differences are a result of the higher life expectancy in the SO-NOMAT scenario. Moreover, migration plays a (modest) role. Above the age of 50, TREND shows a lower average household size compared with both other scenarios. Below this age, TREND occupies a mid-position.

4.4. Distribution by household position

To conclude this short summary of simulation results, fig. 7 shows the distribution of individuals by household position. The following categories are distinguished: children in a two-parent household (cf. 2pf), children in a one-parent household (ch. 1pf), non-married cohabitants (nm coh), married cohabitants (m coh), individuals living alone (1 al), and heads of a one-parent household (hd 1pf).

The graph shows a notable difference in children between EGO-MAT and SO-NOMAT. The percentage of (married or not) cohabitants is much higher in SO-NOMAT, with a reverse situation for individuals living on their own. The proportion of children living with both parents

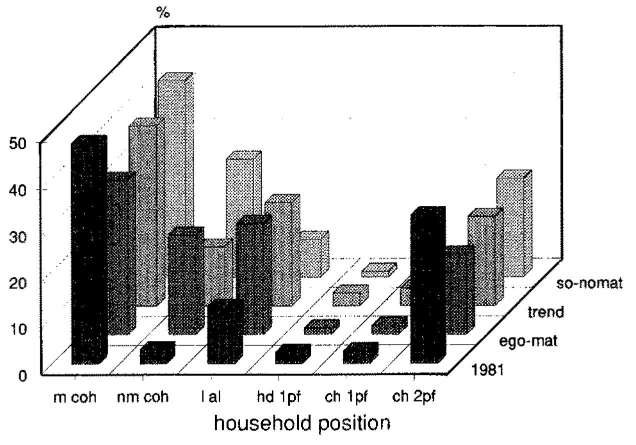

Fig. 7. Distribution of persons by household position.

in the TREND scenario lies between SO-NOMAT and EGO-MAT, but is substantially lower than in 1981. Differences are largest in the proportion of unmarried cohabitants. In all three scenarios the proportion increases strongly between 1981 and 2010, while the proportion of married cohabitants declines. In 1981, the percentage of people living on their own is only a few percentage points higher than SO-NOMAT shows in 2010, whilst these percentages are almost alike for TREND and EGO-MAT.

5. Summary and discussion

In this article two methods were brought together in order to estimate and analyse future household structures in the Netherlands. The first method, the *scenario method* (as opposed to a more conventional 'time series extrapolation' method, was used to construct three (widely) differing context scenarios. These context scenarios function as alternative social environments of the household system in 2010, the year under investigation. Given these context scenarios and a set of hypotheses relating relevant elements of the context scenarios to the household processes, future input parameters of the household model were determined. Subsequently a second method, *microsimulation*, was used to calculate the future household structure in a consistent way.

Emphasis was placed on methodological rather than on substantive issues. The latter played an illustrative role only.

Two new context scenarios were designed: EGO-MAT (representing a highly materialist and individualist technocratic society) and SO-NOMAT (representing a re-'socialized', unwealthy, post-materialist society). We also added the household dimension to the 2010-forecast of the Netherlands Central Bureau of Statistics and labelled it the TREND scenario. TREND can, in fact, be considered a product of 'conservative' trend extrapolation, whereas EGO-MAT and SO-NOMAT represent more or less extreme pictures of future societies.

The results of our analyses should, in some respects, be considered illustrative only, mainly because we had to include highly aggregated hypotheses, both in structuring the context scenarios and in applying household theory. The economic environment has, after all, still been largely neglected. Our next step will be to integrate this economic environment (as expressed in, among other things, the labour market, education and income variables) in the system. In addition, the determination of future values of the parameters may be improved in a future development of the project by consulting experts, using for example a Delphi-like approach.

Appendix

Table A.1
Main parameters for EGO-MAT and SO-NOMAT for the year 2010. [a]

	EGO-MAT	SO-NOMAT
Leav. parent. home and form. 1p-h.h (stream 1)		
Intensity	0.65	0.35
Mean age	22.00	22.00
Ever marrying (stream 2+4+6)		
Intensity	0.35	0.50
Mean age	27.30	24.00
Ever engaged in non-marit. cohab. (as first pair form.) (stream 3+5)		
Intensity	0.45	0.42
Mean age	24.00	23.50
Total pair formation rate (stream 2+3+4+5−6)	0.75	0.90
Separation of marital family households (stream 7+8)		
Intensity	0.34	0.20
Mean age	35.00	37.00
Separation of non-marital households (stream 9+10)		
Intensity	0.40	0.31
Mean age	31.00	32.00
Total separation rate (stream 7+8+9+10)	0.30	0.23
Recohabitation of divorced		
Intensity	0.29	0.38
Mean age	41.00	41.00
Recohabitation of non mar. separees		
Intensity	0.22	0.42
Mean age	36.00	35.00
Total recohabitation rate	0.075	0.092
Overall fertility pattern (marr. and unmarr. couples)		
Parity spec. intensity:		
Prop. 0-child fam	0.40	0.10
Prop. 1-child fam	0.30	0.05
Prop. 2-child fam	0.20	0.30
Prop. 3-child fam	0.10	0.35
Prop. 4-child fam	0.00	0.20
	1.00	1.00

Table A.1 (continued)

	EGO-MAT	SO-NOMAT
Total fertility rate	1.00	2.50
Mean age at birth of:		
First child	30.00	25.00
Second child	31.50	26.50
Third child	33.00	28.00
fourth (+) child	–	29.50
Overall mean age	30.75	26.55
Migration (abs. number)		
Outmigration	2 × level of 1985	0.5 × level of 1985
Immigration	Trend in NCBS-forecast 1985	
Mortality		
Life expectancy males	76	81
Life expectancy females	80	83

[a] Except for the input parameters for migration and mortality, intensity figures are expressed as 'total rates', and are derived from an original expression in overall occurrence-exposure risks (see section 3).

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